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Principles for designing online self-paced corporate training

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Principles for designing online self-paced corporate training

by

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Abstract

Self-paced online corporate training is growing rapidly in today's technology-based society. Instructional designers have an important role to ensure that online courses are designed to meet the needs, goals, and learning outcomes of the learner and their employer. In the present study four participants' experience with a self-paced online training course for practicing engineers was examined. A case study for each participant that focuses on three instructional design decisions incorporated into the online training course is described and analyzed. The instructional design decisions were guided by three principles developed for designing self-paced online corporate training. Results suggest that the experience level of the learner plays an integral role in their need for structure in course content, that learner engagement can be increased through on-screen annotation, and that the use of picture-in-picture in instructional videos increases the social connection with the instructor and course content. Implications and recommendations are given for each finding and areas for further research are suggested.

Introduction

Use of the World Wide Web for distance education and online corporate training is quickly becoming the norm in 21st century U.S. society. Many companies and corporations, big and small, are increasing the use of online education and online training courses for their employees to help them keep up with increasing information demands in their field. According to an American Society for Training and Development report (ASTD, 2007), U.S. organizations spent $129.60 billion on employee training in 2006. Currently, the most pervasive method for training is face-to-face with an instructor in real-time; however, recent reports show that this is declining. In 2001, 76% of corporate training was real-time instructor led, whereas in 2006 that number dropped to 65%. Conversely, the use of technology-based delivery methods for learning has displayed a consistent upward trend. In 2001, 11% of corporate training used a technology-based delivery method and in 2006 that grew to 30%. At 63%, self-paced online learning is the most frequently used technology-based training method (ASTD, 2007). It has changed how students learn and teachers teach by using the Internet as a medium for sharing information through the use of new interactive and collaborative approaches.

As distance education continues to become more pervasive in our society, it is important that we understand that self-paced learning in an online environment differs from learning in other educational contexts. One important difference is the type of interaction that can occur. Interactions occur between the student and teacher, student and other students, and/or student and materials (Moore, 1993). In a traditional face-to-face setting all three interaction patterns are typically present. These educational contexts allow social interactions to occur as students engage in dialogue with one another and the instructor. With traditional

correspondence classes the social interaction between the student/teacher and student/students is minimized or even eliminated and more emphasis is placed on the student/materials interaction. However, the context of a self-paced training program is different. In this context, interactions rely solely on the student/materials interaction as the materials shape and guide the experience. Online self-paced training places more emphasis and responsibility for learning on the individual and requires him or her to be more active in the learning process.

Technology-based instruction offers new affordances that can be used to meet the interaction needs of the learner in online self-paced courses. Although self-paced training focuses on the interaction between the student and materials, online streaming video is a technological affordance that is “more adaptable and interactive” (Shephard, 2003, p. 297), potentially improving this interaction. Affordances include the use of online streaming video, upon which picture-in-picture and instructor annotation can be overlaid, as well as advances in online course management systems. Picture-in-picture allows for the instructor to be visible to the learner alongside the learning content. This helps the learner pick up subtle cues from the instructor such as facial expressions, voice intonation, and mannerisms, enhancing the student/instructor interaction. Annotation is made possible by advances in pen tablet monitors, which allow for explanation of the content while the instructor is modeling, also improving the student/instructor interaction. Sophisticated screen capture programs (e.g. Camtasia and Captivate) can be used to record computer screens and presentations, including live annotations made by the instructor. Finally, online course management systems allow the course designer or instructor to present and structure the material in multiple formats such as weekly assignments or individual self-contained modules. Purposely structuring content to

fit learners prior knowledge and existing conceptual structures allows the learner to more easily assimilate and make sense of new information (Piaget, 1973).

As we continue to develop our understanding of online learning environments, we must also recognize that learners in these environments are primarily adults. Recent instructional design research (Huang, 2002; Klopfenstein, 2003; Dobrovolny, 2006; Cercone, 2008) addresses the importance of learner characteristics and how learning occurs in adult online learning; however, little research has examined how new technological advances can help meet the needs of the adult learner in an online self-paced training course. Instructional designers and course developers must understand the important role they play in the adult learners understanding of new material and the fact that learning for adults differs from younger learners. “Adult learners have greater responsibilities (e.g., families and jobs) and situations (e.g., transportation, childcare, the need to earn an income, etc.) that can interfere with the learning process” (Cercone, 2008, p. 139). An adult learner also tends to be more motivated because content in self-paced online training is directly relevant to their everyday work lives and promotes higher job satisfaction.

The purpose of this thesis is to examine how elements of a self-paced instructional module can improve the learners’ assimilation of complex highly structured content, enhance learners’ perceptions of social interaction, and improve learners’ engagement with course content. It is important to understand that an instructional designer can have a tremendous impact on a course through their design decisions. Therefore, guiding questions for the study are:

- Does the level of prior knowledge with course content influence the degree of organization and structure preferred by the learner?

- Do participants perceive a sense of engagement/interaction with the course content through the use of on-screen annotation in the instructional videos?
- Do participants perceive a sense of social presence/interaction/connection between the instructor and themselves through the use of picture-in-picture?

Drawing on ideas from constructivism, andragogy, and online learning, principles for self-paced online adult training were developed and used in the creation of the instructional modules for the course. Materials were then field tested with four practicing engineers and their perceptions of the effects of the design elements were analyzed.

Providing information on my epistemological stance and personal history will help you, the reader, understand the lens I am looking through and why instructional design is important to me. For the past two years I have been working as a full-time graduate student in the educational field. During this time I have been a teaching assistant for an undergraduate course on instructional technology. This has allowed me to teach pre-service teachers how to incorporate technology into their teaching and how to evaluate its effectiveness. In addition, I have been working in the Engineering Distance Education Department for the Engineering College at my University. I am primarily in charge of developing non-credit courses for training purposes geared towards various engineering areas. Prior to graduate school I was a high school Mathematics teacher for a year and a half at a small school district. Given my experience with teaching high school and young adult learners, along with developing online courses for the Engineering department, I have developed a passion for instructional design and distance education. Finally, it is important to disclose that my future plans include being employed as an instructional designer for private industry and educating adult learners.

Literature Review

For years, principles for designing instruction have been used to develop traditional coursework. They provide guidance during design and planning in order to develop courses that will best educate the learner. In the present research study, three principles have been developed that are grounded in the conceptual frameworks of constructivism, andragogy (adult learning), and online education. First is cognitive constructivism, which focuses on the individual learner and their sense making of the world around them. Next, andragogy describes how adult learners are self-directed and intentional in their learning (Knowles, 1975; 1980; 1984). Finally, the third framework addresses what Duffy (2001) describes as principles of online learning. Online learning provides some unique opportunities for self-paced learning and includes key attributes such as focusing on learner's goals, structuring content, and promoting interaction through modeling.

Principles for Adult Self-paced Online Training

Analyzing the frameworks of constructivism, andragogy, and online learning led to the development of the principles for adult self-paced online training (figure 1). The following presents each principle along with a discussion of how constructivism, andragogy, and online learning were used in their development.

Figure 1: Principles for Designing Online Self-paced Corporate Training

Experience and Structure

Building on learners' already constructed experience and prior knowledge is important. Constructivism tells us that learners are developmental by nature and that we continually build and develop our existing schemata (Piaget, 1973). Although all constructivists are interested in understanding what knowing is and how people come to know, they may differ on what they see as the reason for knowledge construction (Philips, 1995). Piaget focuses on the biological and psychological aspects of the individual learner and draws heavily on the concept of adaption. Von Glasersfeld (2005) describes Piaget's idea of adaption and how it applies to the epistemology of cognitive constructivism:

> Piaget took the notion of adaption out of the biological context and turned it into the cornerstone of his genetic epistemology. He had realized early on that

> whatever knowledge was, it was not a copy of reality. The relationship of viable biological organisms to their environment provided a means to reformulate the relationship between the cognitive subject's conceptual structures and that subject's experiential world. Knowledge, then, could be treated not as a more or less accurate representation of external things, situations, and events, but rather as a mapping of actions and conceptual operations that had proven viable in the knowing subject's experience. (p. 4)

Von Glasersfeld's explanation shows us the importance of the relationship between a learner's prior experience and the conceptual mental structures that are created in the mind during learning. It is the development of these mental structures that constitutes learning, but how does this development take place?

Piaget (1973) looked at knowing as a way of cognitively organizing or structuring your thoughts and ideas to make sense of the world. When what an individual knows changes, this is referred to as learning (figure 2). As an individual experiences life, they are constantly integrating new knowledge into prior knowledge. When they make sense of this new knowledge, they have achieved a mental state of equilibrium. It is this state of new mental equilibrium that Piaget believed every individual wants to achieve. However, he saw it as a constantly changing state of equilibrium, because one must take into account perturbations that do not coincide with one's previous state of mind.

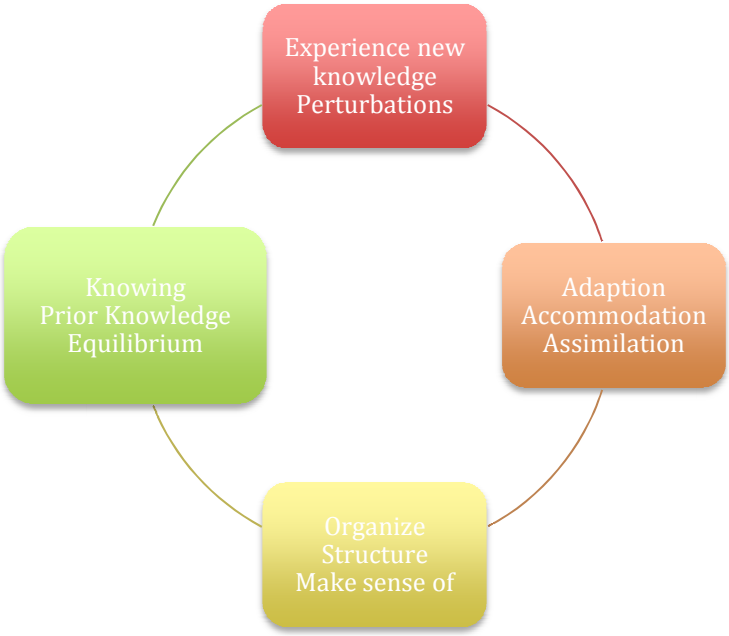

Figure 2: Simple Diagram of Knowing and Learning

As an individual changes what they know, they are adapting their existing mental structures to account for new knowledge—or learning (Piaget, 1973). Learning requires that the individual be mentally and physically active, and adaption is the process of assimilating and accommodating the new knowledge. So, the process of organization and adaptation are two crucial elements Piaget describes that influence an individual's ability to learn new information and that this systematic process is ongoing and developmental over one's life.

Given that an individual comes to know and understand new knowledge through organizing and adapting, educators can design instruction to develop and build on an individual's prior knowledge and experiences. Basic core principles of constructivism are what drive educator's instructional methods and the idea of constructivist pedagogy. Constructivist pedagogy suggests that if people organize and make sense of the world in certain ways, then we can design instruction to help structure their sense making. Jonassen et

al. (1995) paints a simple picture of what constructivism is and summarizes what constructivists believe:

> Constructivists believe that our personal world is constructed in our minds and that these personal constructions define our personal realities. The mind is the instrument of thinking, which interprets events, objects, and perspectives, rather than seeking to remember and comprehend an objective knowledge. The mind filters input from the world in the process of making those interpretations. The important epistemological assumption of constructivism is that knowledge is a function of how the individual creates meaning from his or her experiences; it is not a function of what someone else says is true. Each of us conceives of external reality somewhat differently, based upon our unique set of experiences with the world and our beliefs about them. (p. 10)

Andragogy and online learning principles argue that the learners' experience and existing knowledge structure play an important role in developing understanding of new knowledge (Knowles, 1990; Duffy, 2001). The sense making of our world, and how instruction can be structured to fit our existing schema is what the instructional designer must focus on. Content must be easily assimilated by the learner and presented in sequential and logical order to provide for understanding and personal development. In the context of an online training course, most typically use course management systems (CMS) or learning management systems (LMS) to aid in structuring material and content for the learner. Therefore, designers of self-paced online corporate training need to ask the question, how can I organize and structure the content to allow for the learner to assimilate to it based on their prior experiences?

Further, the foundational principles of andragogy and online learning stress the importance of the individual taking control of learning. This introduces the principle of making the content relevant to the learner and leads us into the next principle.

Relevance

As an active learner one must interact with the environment in a hands-on fashion. Instruction that is designed as hands-on must also be presented in the context of application to real-life situations which helps orient the learner to what they are ready to learn (Knowles, 1990). The online learning lens recommends that the focus should be on engaging the learner to meet their individual needs and goals. Further, online learning suggests that assignments should be relevant to what the student will need and use outside the virtual classroom (Duffy, 2001). To meet this principle instructional designers must find ways to make the content feel hands-on and incorporate real-life problems. A way to accomplish this in an online self-directed course is through modeling real-life problems that are relevant to the learner.

Within andragogy, designing content that is relevant to the learner directly relates to the fact that adults who pursue online corporate training are life-wide learners. Reischmann (2004) provides a concept map of different areas within the domain of andragogy (figure 3) and two types of “life-wide” learning, intentional and unintentional. Since the present study focuses on training, this fits within intentional and self-directed life-wide learning. Throughout the remaining literature, life-wide learner and adult learning are used interchangeably.

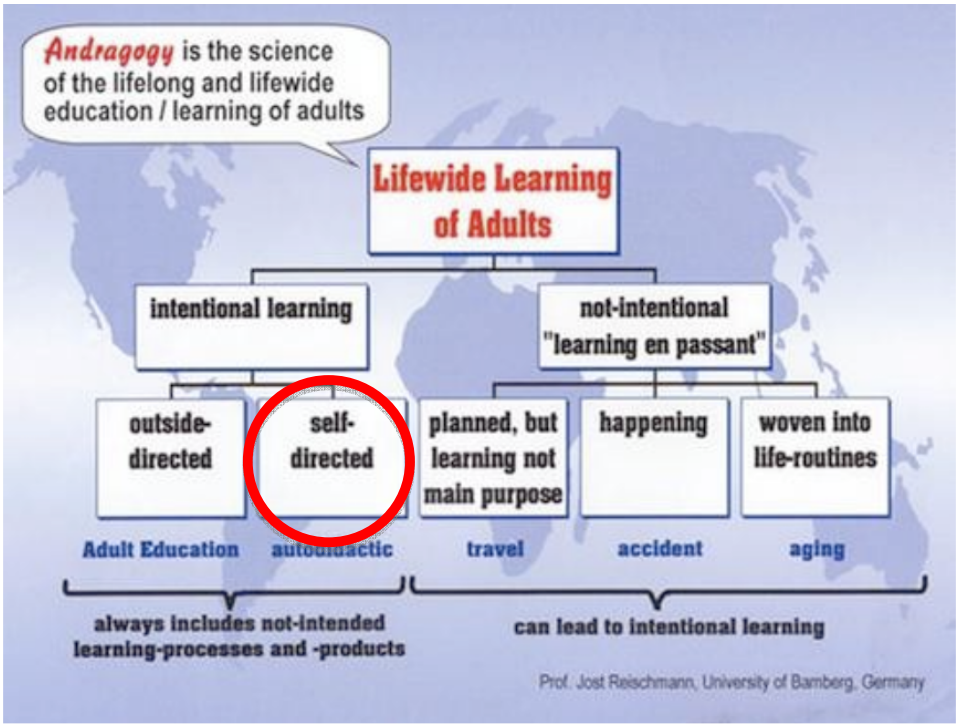

Figure 3: Areas within the domain of Andragogy (Reischmann, 2003).

Adult self-directed learning has a number of conceptual dimensions (Long, 1992). These include sociological, pedagogical, and psychological. With regards to sociological aspects, self-directed learning is equated with independent learning and two conditions exist for this. First is physical separation, where the learner is considered a solitary learner in isolation (e.g., correspondence study or computer-assisted instruction). For online corporate training, the learner proceeds through a training course in isolation. The only interaction is between them and the content presented on the screen. Second, interpersonal power, directly relates to the learner being autonomous and in charge of his or her own learning (Long, 1992).

The pedagogical dimension emphasizes the importance of the freedom of the learner to “set their own learning goals, identify and use resources, determine the effort and time to be allocated to learning, and to decide how and what kind of evaluation of the learning will

take place" (Long, 1992, p. 2). Although Long uses the term pedagogical to describe how the learner will pursue learning, the present study uses andragogy instead of pedagogy so that the principles of Knowles' adult learning come to mind instead of these socially accepted connotations of the term pedagogy.

The final, and most critical, dimension of self-directed learning is psychological (Long, 1992). This is the "degree to which the learner, or the self, maintains active control of the learning process" (p. 3). If a learner is to engage in autonomous learning and be independent in learning the content, he or she must be psychologically self-directed. "The learner has consciously accepted the responsibility to make decisions, to be their own learning change agent, rather than abrogating the responsibility to external sources or authorities" (Kasworm, 1988, p. 69). In addition an individual learners' social interaction is important for group activity, however, since materials for the present study are for individual learning, this is beyond the scope of this study.

A psychologically self-directed learner can be thought of as intentionally learning what he or she needs to know. An intentional learner refers to the "cognitive processes that have learning as a goal rather than an incidental outcome" (Bereiter and Scardamalia, 1995 in Resnick, 1989, p. 363). Although a learner may have the goal of learning one thing in particular, there usually is some unintentional learning that comes along with it. For example, a person has the goal of learning how to bake a cake. In the process of setting the timer on the stove they figured out how to set the clock to the correct time, which they may not have known how to do before. The intentional learning goal was met (baking a cake), but there was also an unintentional outcome in the learning process (how to set the clock).

Some may equate the concept of autonomous learning with intentional, but the present study uses intentional learning because there is debate about the definition and characteristics of autonomous learning (Knowles, 1980; Merriam & Caffarella, 1999). Autonomous may suggest to some the freedom from external direction and with intentional learning, external resources and contacts are usually encouraged.

The literature on self-directed and intentional learning shows the importance of understanding the adult learner in order to design online corporate training relevant to their needs. This type of design allows the adult learner to take ownership of his or her learning and readily apply it to the job.

Interaction

Learning is a social activity that depends on connections with other human beings (Vygotsky, 1978). This principle is evident in the frameworks of constructivism and online learning, as both emphasize the importance of interaction and communication with peers, teachers, family, etc. Andragogy does not explicitly state that social interaction is a key to learning for adults. However, Knowles (1990) does discuss the importance of self-concept and that the adult learner strives to be seen by others (e.g., co-workers, friends, family) as capable of making their own decisions, but are willing to seek out assistance from peers when needed.

Social constructivists view learning as a social activity and stress the importance of connecting with other human beings such as our teachers, peers, and family. They recognize the social aspect of learning and view conversation, interaction with others, and the application of knowledge as an integral component of learning (Dewey, 1916; Vygotsky, 1978).

There are many types of online learning that can incorporate features to improve social interaction (World Wide Learn, 2009). However, in self-paced online corporate training, designers are limited on the type of online course they can design. The instructor is vital for promoting student interaction and collaboration, modeling and sharing deep questions, and facilitating learning (Duffy, 2001). With this said, it is essential that the designer understand that self-directed online learning is much different than regular online classes, which may include collaboration and communication with the instructor or other learners. Self-directed learning relies heavily on the individual learners prior knowledge and their need to know the material, as was mentioned in Knowles' (1990) principles of andragogy. Online learning draws on certain principles of learning and instruction. Key among these principles is that learning involves making sense of the world and instruction should support that sense making activity (Duffy, 2001). The majority of corporate training courses are limited to interaction between the content and learner only, which is the case for the present study. This means no physical contact is made between the instructor and learner or even between the learners themselves. Since it is often difficult to imitate real-life circumstances in an online environment, designers need to think about and ask themselves, how can I meet the social interaction needs of the learner?

The three guiding principles for designing self-paced online corporate training presented are intended to provide a starting point for instructional designers when designing online training. They are not intended to encompass all aspects of online training as each specific online training course may have its own unique goals to meet.

Emergence of Online Corporate Training

Traditional corporate training has been greatly influenced with the emergence of online

self-directed and intentional learning. The American Society for Training and Development, a leader in corporate education, estimates that U.S. organizations spent $134.39 billion dollars on employee learning and development in 2007 (ASTD, 2008). Many corporations have developed their own online universities (Rudestam & Schoenholtz-Read, 2002). Motorola University, McDonald's Hamburger University, and General Motors University are just a few of the many, but smaller companies and those that don't have the finances and resources to develop their own courses and training programs still can utilize online education for educating their employees. As the ASTD (2007) states:

> Many organizations have turned to technology to design, deliver, and manage learning and performance. Adoption of e-learning frequently produces efficiency gains, increased content reuse, and decreasing costs for learning delivery. As e-learning has become more prominent, traditional instructor-led classroom sessions have accounted for fewer available learning hours than in the past. Traditional instructor-led delivery has declined in use for many reasons, such as high fees charged by instructors and time missed at work by employees. (p. 5)

With current economic challenges in the United States, many companies and corporations are looking for ways to reduce costs yet still educate their employees. Thus, it would make sense that they are moving to online training courses as part of the solution to their financial woes. Further, audio and video training has provided an important role in our country's history (Treat, Wang, Chadha, & Dixon, 2006) and the use of multimedia in an online environment is an emerging trend among corporate training. ASTD (2007) reported that the consolidated average for technology-based learning is approximately 30% in 2006, which is a 19% increase from 2001.

The following methodology section will describe the participants, the context of the course, the course management system, course content, and the instructional design decision based on the previous three principles.

Methodology

Participants

Participants selected for this study were four practicing male design engineers working for engineering companies in the Midwest. Their ages ranged from twenty-five to sixty-one and work experience ranged from two years to forty-two years. Further detail on individual participants is provided in the results and discussion section.

A design engineer is one who tells manufacturers how products and parts are built according to specific dimensions (e.g. size, weight, and height) and tolerances. A design engineer's goal is to design a product or part that uses minimal material and takes minimal attempts to manufacture, thus cutting down on operating costs. To achieve this goal the design engineers and manufacturers must have a common language to communicate part designs and features.

Context

Materials for this training course were developed for engineering corporations to train their employees (design engineers and part manufacturers) on Geometric Dimensioning and Tolerance (GD&T). The entire training course is self-directed and online, allowing for the individual to access the content any time and any place. The course is self-contained, meaning that all materials are accessible through the course website. Creating a course that is self-directed and self-contained is important for instructional designers and provides constraints on what design decisions can be made. For example, discussion forums and the ability to post questions are not possible because there is no instructor or other students. Employees engaging in this training may have co-workers and engage in communication outside of the course, but this kind of interaction is beyond the scope of this study.

Content

Instructional content used for this study addresses GD&T. GD&T is a symbolic language used on engineering drawings and computer generated three-dimensional solid models. The American Society of Mechanical Engineers (ASME, 2009) describes GD&T as:

> A component within mechanical design and is an essential tool for communicating design intent – that parts from technical drawings have the desired form, fit, function and interchangeability. By providing uniformity in drawing specifications and interpretation, GD&T reduces guesswork throughout the manufacturing process – improving quality, lowering costs, and shortening deliveries.

Course Management System

A Course Management System (CMS) is a tool that allows instructors, universities, and corporations to develop and support online education. Three prominent CMS tools are blackboard, WebCT, and Moodle. Features include course calendar, events, integrated email, discussion boards, chat, wiki pages, and blogs. For self-directed courses many of these features are difficult to incorporate because of limited communication among instructors and students. For this study the CMS was used solely as an online management tool organize and store the video content and assessment features of the GD&T course.

The GD&T course was developed using an open source CMS called Moodle. Moodle was designed to help educators create quality online courses and is used all over the world by universities, schools, companies and independent teachers. Moodle uses an open source platform that is completely free to use and the design and development is guided by social constructionist pedagogy (Moodle, 2009).

Instructional Design Decision #1: Organization and Structure

The first instructional design decision of this study was based on the first guiding principle for designing self-paced online corporate training, experience and structure. Focus was on the learners' prior knowledge and experience, along with the organization and structure of the course. Since different levels of individual learners' prior knowledge were assumed, organization of the content required the development of twelve different learning modules based on elements of GD&T (Figure 4). The modules were structured sequentially with more fundamental concepts listed first and more complex later. By doing this it was hoped that a broader range of design engineers would be able to benefit from the course given their varying experience levels. Further, given the individual learner's needs, they were able to decide for themselves what content was best for them to view at a particular time. For example, a more experienced design engineer would have the option to choose not to view the earlier modules aimed towards the fundamentals of GD&T and move directly to more complex modules. Conversely, a participant with less experience may have chosen to start from the first module because the focus was on the fundamentals of GD&T, and then progress through the remaining modules in order. As an adult learner, this control allowed them to make their own decisions based on their own knowledge and what they need to know.

Within each module were instructional videos, which contain the content of GD&T (Figure 4). Since the concept of GD&T is complex, each module was structured into shorter video segments. This was important for maintaining the attention of the learner and allowing them to process information in smaller chunks (Ally, 2004). Therefore, depending on the

content of each module, there were anywhere from one to five interactive instructional videos ranging from fourteen to thirty-four minutes in length.

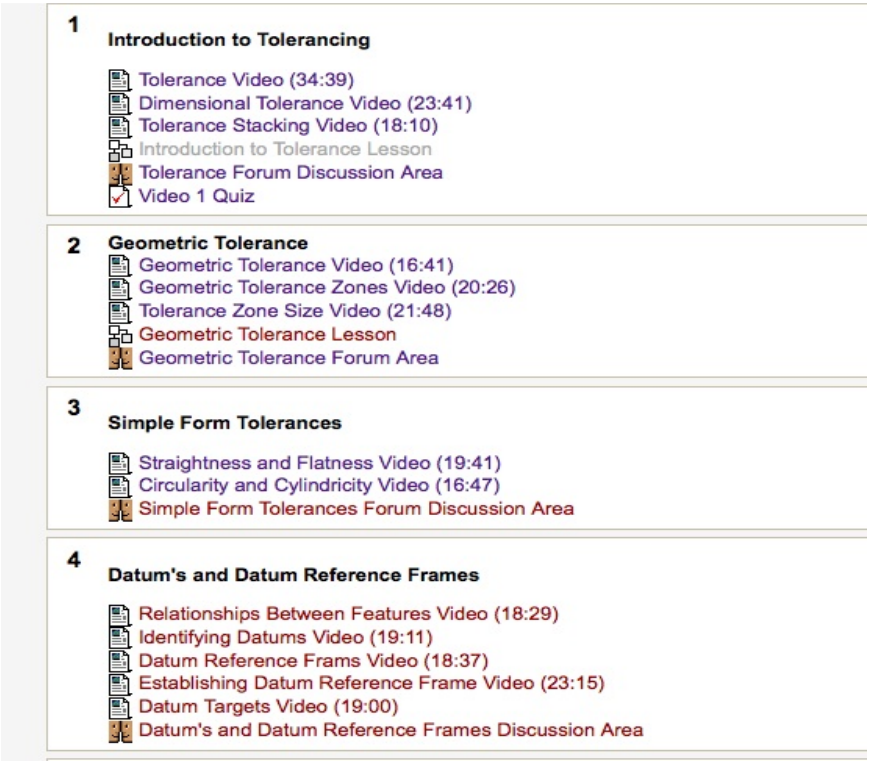

Figure 4: Screenshot of GD&T course

Organizing and structuring the content for the learner is intended to help them assimilate the information more quickly and develop better understanding of the GD&T concepts. The framework of constructivism was most influential in the structure of the course because of the emphasis it places on the individual's experiences. Figure 2 in the literature review shows the developmental and cyclical nature participants progress through as they engage in experiences and new knowledge throughout their life. By relating this to the design of the course we can see that when the individual encounters new knowledge of GD&T they must be able to assimilate new information to fit their existing mental schema and develop a new mental schema (equilibrium). Therefore, the decision to organize and structure the

course with sequential modules and instructional videos of increasing complexity may help the individual better assimilate the new knowledge and continue on in the course.

Instructional Design Decision #2: Annotation

The second instructional design decision of this study was based on the second guiding principle for designing self-paced online corporate training, relevance. Based on this principle the content becomes relevant to the learner when it has a direct impact on their job. The individual becomes an active learner when he or she is engaged in the relevant content. In this self-directed, online course face-to-face modeling by the instructor was not available; therefore, to engage the learner in the content an instructional design decision was made to use live annotation (Figure 5). Annotation was made possible with pen tablet monitors and helps the learner become actively engaged as the instructor models relevant real-life design engineering problems.

Annotation was also used to help present a perception of interaction between the instructor and the learner that could not otherwise be achieved. This directly relates to the third guiding principle of designing self-paced online corporate training. As the instructor models a problem the student is able to see exactly what the instructor is writing and hear them explain as they model. This perception of interaction is intended to aid in the perception of social interaction that would otherwise not be achieved.

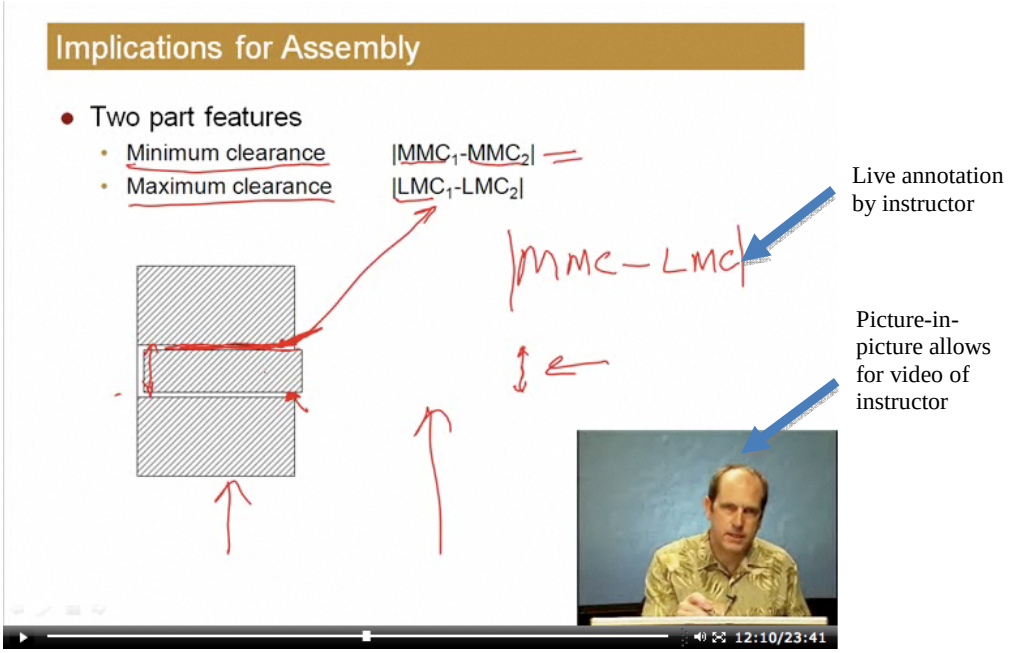

Figure 5: Screenshot of instructional multimedia video

Instructional Design Decision #3: Picture – In – Picture

The third and final instructional design decision of this study was based on the third guiding principle for designing self-paced online corporate training, interaction. This principle places a great deal of emphasis on the social interaction of the learner. Given the nature of self-directed online training courses (interaction is solely between the student and materials), meeting this principle proved to be difficult. However, an instructional design decision was made to include the use of picture-in-picture (Figure 5), which visibly shows the instructor as he is modeling and talking to the learner about the content of GD&T. The intent was to increase the perception of social interaction with the instructor. Coupling this feature with the decision to include live annotation, the perception of listening, watching, and interacting with the instructor is provided for the learner. Although this type of social interaction varies from Vygotsky's (1978) and Duffy's (2001) view of social interaction with students and teachers, it is expected that participants would perceive that more interaction is

occurring from visually seeing the instructor.

The GD&T course also incorporated the idea of shared knowledge and shared meanings. Since this training program was designed specifically for design engineers, if a company uses this training course it is hoped that communication errors will be eliminated when referring to part design specifications. This is because all employees would have been trained with the same terminology, methods, and practices and thus has the same conceptual knowledge of GD&T. However, what is important is the individual who develops the understanding for him or herself. “Since they are individual constructs, one can never say whether or not two people have produced the same construct” (Von Glasersfeld, 2005, p. 5). Therefore, we may be able to design the training with the notion in mind that all the employees should be able to communicate design part features without any problems; however, other factors (e.g., prior knowledge, personal life, etc.) may have an impact on this.

Procedures

Instructional Development. Three individuals contributed to the design and development of this course; myself as course designer and developer, my supervisor, and the instructor. The course instructor approached the engineering distance education department at our university with the idea of creating a course on GD&T. The instructor had knowledge of the content, but needed instructional design assistance to develop a course. Design and development was loosely based on the ADDIE model (Dick & Carey, 1996). Negotiations between the instructor, my supervisor, and myself included how the course was to be structured, interactive features it could include, and how the content was to be captured and shared. It was my responsibility to capture and edit the video modules, use a CMS to build

the course and organize the content, and work with my supervisor and course instructor to produce the course. Designing the course as a part of my thesis research allowed me to gain valuable research experience, formative assessment from participants, and experience with instructional design.

Participant Selection. To select participants I contacted local engineering companies through email and phone to ask if their company employed design engineers and if they would like to participate in a research study. The growing importance of GD&T in the design engineers' profession was enough to spark interest in local engineering companies and locating participants was not difficult. I explained to participants the benefits they would gain from the experience. After explaining the basics of the study and GD&T course, initial meeting times were set up based on participants' availability.

Data Collection. Data collection consisted of one face-to-face interview lasting approximately two hours. A small conference room, which included an empty table and chairs at the participant's workplace, was utilized for the interview. The interview was video and audio recorded for transcription and data analysis purposes. A pre-planned agenda was followed for guidance (Appendix).

Along with conducting this research study, the development of this course was also a requirement of my job at the university engineering distance education department. This meant that there may be an element within the interviews where the participant asked a question not relating to the design of the course such as the cost of the training course, professional development credits they can earn, or how long will they have access. Although these are relevant questions, I made clear that the focus of the interview was on their prior experience, course design, and course content and any questions beyond the scope of the

study were noted and passed along to the appropriate contact person. Participants also received contact information for the engineering distance education department allowing them to ask questions of this nature directly to my department supervisor.

Prior to the start of the interview the camera and tripod were set up in the room and positioned so that I could obtain the participants reactions and also record their activity on the laptop computer. Given security restrictions of the company's Internet policies, participants were asked to provide their own laptop. The first portion of the interview was focused on introducing myself to the participants and establishing rapport. This lasted approximately ten to fifteen minutes. I wanted the participants to understand my background and feel comfortable to talk about anything regarding the training course or their work. Reviewing the purpose of the study and obtaining informed consent was also completed during the initial stages of the interviewing process.

The second portion of the interview focused on questioning the participant to gain knowledge of their background, experience, and prior knowledge with design engineering, specifically GD&T. This lasted approximately fifteen to twenty minutes. The third portion of the interview shifted to the actual online training course and lasted about ten to fifteen minutes. Prior to the interview I set up participants with a Moodle account and enrolled them in the GD&T training course. By doing this we were able to quickly transition into engaging with the course and content. Once logged into the course, I asked each participant to look around on the home page, but not to click on any links yet. As they did this I asked questions regarding the course layout and structure.

Upon answering the final question I told them to go ahead and choose a video and click on the link upon answering the final question. The fourth portion of the interview was

observation and involves the participant watching and interacting with the instructional video of their choice. This was the longest part of the interview lasting approximately forty-five minutes. During this portion I asked participants questions about the annotation and picture-in-picture features of the video as well questions about the content of the course.

Data Analysis

A computer software program designed for qualitative analysis, Transana, was used to transcribe the recorded interviews and analyze the data. This program was chosen because of its ability to integrate the audio and video captured from the interviews and place timestamps in the transcripts so that the actual interview could quickly be accessed for more thorough analysis and visual confirmations of the participants' actions.

As I was conducting the interviews and observation of the participant, themes were already beginning to emerge. Upon completion of transcribing the recorded audio from the interviews major themes were identified. To ensure that I was interpreting the data correctly, I revisited the transcriptions and, if needed, the original video. Completed descriptions of each case study were sent to participants as a *member check* (Creswell & Miller, 2000). I asked them to verify that each description was accurate and to comment on anything that was not. All four participants confirmed that their description was accurate and that nothing was described incorrectly based on their recollection.

I found the best way for me to organize themes was to take notes as I read through each transcript and jot down my interpretations. From here I used Transana and organized the major themes into headings. Within each heading I was able to use the computer program and code the transcripts. Coding was done at the sentence level, instead of individual words or short phrases, so that I was able to understand the context of the text when I re-read it.

After multiple passes through the transcripts, coding the data based on keywords, and placing them within appropriate themes, I felt that I had a firm interpretation of the participants' experience with online courses, attitudes towards the GD&T course, and instructional design features that were incorporated.

Results

I will first present four descriptive case studies that provide a narrative of each participants' experience with the online course for this research study. Each narrative will include a description of the participant, their previous experiences with online courses, and their interaction with the online course for this study. After presenting each case study the focus will shift to the analysis of the four individual's participation. Analysis will focus on the three instructional design decisions incorporated into the course, other themes that emerged from their participation, and implications of the instructional design.

The term case study is often used interchangeably with other qualitative research terms and is not used in any standard way (Hammersley & Gomm, 2000, p.1). This causes confusion about what a case study is and what it entails. To avoid this the following explains why a case study approach was chosen and it's purpose.

An exploratory case study approach was used based on the context and nature of this training course and content. Case study research lends itself to consist of elements in a *bounded system* (Smith, 1978), or single entity, that has a finite quality about it (Merriam, 2002, p. 178). In this study the bounded system consists of the specific training course on GD&T, the three participants, duration of the study, and the place where each participant was located. Some skeptics may see this as a negative and being less generalizable; however, much can be learned from a particular case (Merriam, 2002, p. 179). Through the following narrative descriptions of each case you will be able to understand each participants' experience and how it can personally apply to your unique context as the reader. After all, "it is the reader, not the researcher, who determines what can apply to his or her context"

(Merriam, 2002, p. 179). Exploratory case study allowed for me to begin with broader guiding questions and narrow the focus based on each participants' experience.

Case Study #1 – Adam

Adam was a twenty-five year old part designer and drafter in his second year of work with a Midwest company. He considers his experience with online courses minimal and explains how his college "just started really pushing online courses. I think I took one online course in college and that was towards the end of it." He described his experience with this course as "basically every week a new assignment would come on for that week and say read chapters five through seven then answer the questions." He felt there was very little interaction between him and the other students because, although they were required to put down thoughts in a discussion forum, you weren't required to read or respond to others so he didn't want to take the time to do it. He just "posted to get it done."

Similar to his past experience with online courses, Adam has had very little exposure to the GD&T content of the online self-directed course for this research study. When asked how he had come to learn what he knows about it, he mentioned:

> I first encountered it [GD&T] in my first year of college. We had an intro course with solid modeling and the first part of the course was actually doing hand drafting. The second part was doing actual modeling in 3D. That was a really quick run through of GD&T and from that point on I never really had an overall class on GD&T to be honest with you.

With very little exposure and experience with GD&T, Adam explained that most of his learning came from communicating with experienced co-workers or by searching for free online resources. He emphasized the importance of being able to quickly access resources

regarding GD&T when he commented, “I’m looking for something that’s more quick [as he snaps his fingers].” When asked to rate his personal level of experience with GD&T Adam said, “at the very beginning personally.”

At this point Adam was able to begin to interact with the self-directed online course. When he came to the home page of the course I asked him to spend some time looking it over and describe what he sees, without clicking on any of the hyperlinks. Adam quickly found the main content of the course by scrolling down and noticing the layout of the “chapters” as he called them. A few seconds later, after looking more closely at the page, he commented, “Oh! These are the videos and this is the length.” Now that he had some understanding of the layout of the course a brief discussion ensued about the content of it and if the terminology made sense to him. He mentioned that he recognized words and had some understanding of what they meant in the first few chapters of the course, but he was confused with the meaning of the content in later sections. “I’m not too familiar with Datums to be honest with you. And actually from tolerance, or from this point (pointing at module number four) on I’m not familiar. I mean I know what gauging is and stuff like that, but not sure what exactly it means.” Not fully understanding the meaning of gauging troubled Adam for a bit and he started thinking aloud.

> I think hard gauge is umm… go, no go gauge. Maybe that’s soft gauge? Cause, like to measure diameters we used to have gauges that were shaped like a horseshoe and they had a piece on each side, one piece a certain length and on the other, another a certain length. So, you put it in and if it went all the way through it was way to small. But if it didn’t go through at all it was way to big… I cannot remember if that was hard

> gauging or soft gauging to be honest with you. I would figure soft gauging would be that range, like the bigger range.

After thinking about the terminology of the GD&T content and trying to make meaning out of it Adam was asked if he would like to see the content presented in a different order based on his understanding of GD&T. He said that it was “hard for him to say” because of his lack of fully understanding what datums are. Similar to his think aloud before on gauging, Adam continued to talk about his knowledge of datums and tolerances.

> The things that stick out is position tolerance more than datums, but maybe datum relates more, maybe you need to know that first before position tolerances, cause what I dealt with here with position tolerance is that when I made something up I didn’t know that if putting that hole there is actually going to be in range and go on the piece it’s being mounted to, you know. It’s got to have some kind of tolerance there that will give the actual position of it. Actually, I think datum is the actual face of the part.

Now that Adam was convinced of his understanding of the content of the course he did think that he would change the order of the ‘chapters.’ “You know that would make sense I think, putting [datums] first then work down through all the tolerances right in a row.”

Prior to selecting his first instructional video for the course to begin watching Adam was asked what he expected to see based on his experience and knowledge of online courses. “I guess I would expect a person talking, obviously. I would expect maybe a computer screen in front and showing dimensioning on a CAD file or something like that, or a drawing.” Adam then watched approximately ten minutes of the first instructional video and was asked

what he thought. He commented, “it wasn’t what I expected, actually it was a lot better than what I thought it would be.” He goes on to say:

> Usually the videos that I see online are just like, the teacher up on a board and one thing is you can barely hear them and I like how he integrated the actual, umm, the notes, outline and everything and he actually draws on there and made you realize it.

In addition to noticing the annotation feature Adam also made comments about the picture-in-picture feature. “It kind of gives you a connection with the actual person talking I think, cause you can actually see him and not just hear a voice.” He also added “it definitely keeps your attention.”

After sharing his thoughts on the annotation and picture-in-picture features of the instructional video, Adam asked, “How are the quizzes? Are there like ten questions per quiz or how does that work?” The quiz feature was explained to him, including that all questions are multiple choice and may include anywhere from six to twelve per module. His curiosity lead him to click on the quiz for the first module to get a feel for how it looked and what questions were asked. After answering a few quiz questions he seems to have a firm grasp of the quiz feature and commented, “I like having the quizzes at the end!”

Towards the end of Adam’s experience with the online course he was asked what he thought about the length of each instructional video and how he saw this course helping him with his work. Losing his focus and attention is important to him and he really likes the fact that the videos are “twenty to twenty-five minutes, I think anything longer than that you start to lose attention. It’s good to break them up like that.” With regard to using the course for his work, Adam talks about how his current employer is “a little different because most parts made are for out there [the factory floor].” Unlike other companies that make parts for

customers his company can get by with less strict part design features. However, he feels a personal obligation to increase his knowledge and understanding of part design because “if we needed to do a part outside I want to make sure I’m sending them a print with no questions asked, this is what we need.”

At the end of Adam’s experience with the online course he was able to view multiple instructional videos and was able to decide if this would be a useful resource for him. He believed that this course could be a good foundation for him given his level of experience with GD&T. Further; he believed it would allow him to quickly access a particular instructional video at anytime depending on his needs while on the job.

Case Study #2: Bryan

Bryan is a 2006 mechanical engineering graduate from a large Midwestern university that is known for it’s strong engineering tradition. Prior to this he completed a two-year drafting/designers degree at a local community college. Growing up he always had a curiosity for fixing broken items around his home, which led to his strong development of problem solving skills. Engineering seemed like a good fit for his personality and his knack for fixing things. As he puts it:

> Whenever I was told about engineering I was told that the main part of it was troubleshooting and that’s a hard thing to define, but as I got older, messing with things and taking things apart… solving problems, technical problems, things that just didn’t work and I wanted to fix… I got a lot of enjoyment from fixing whatever problem was there, mechanically, or if it was on a computer or something like that. That really appealed to me and I kind of figured out that’s what was done in engineering, so that kind of steered me towards that direction.

Bryan's strong educational background serves as a solid foundation to understanding part drafting and design. He has been with his current employer for approximately three years and currently uses computer aided drafting (CAD) for designing parts and thus has a strong desire to understand GD&T. Bryan's first encounter of GD&T came in the form of video laser discs when he was a sophomore in college. He described his first exposure as "incredibly boring and drawn out explanations." When asked to describe what made it boring he commented, "Well, it was a laser disc! Imagine when those were made, the tone, and the type of video. The instruction was boring, the instructor was monotone, it kind of put you to sleep."

Bryan's experience with online courses consisted of four or five courses while in undergraduate studies. Most recently he has completed two graduate online courses while working full-time. When asked to describe his experience he chose to comment on the two of his most recent online courses saying, "It was difficult because you weren't there, basically it was just a video of the lecture." The part that was difficult to him was the lack of communication between him and the instructor. As an avid problem solver Bryan knows the importance of being able to use all of his resources to find solutions to his problems. If he cannot communicate with the instructor and find the answer to his question at that time, then it's difficult for him to continue. However, the other online course "was easier because the class format was more discussion based and so we were almost forced to submit questions to the instructor and he would talk about it in class."

At this point Bryan was asked how he thought a self-paced online course on GD&T would be beneficial to him. "I would use it to reinforce what I know. The thing that I've learned about GD&T is how much I don't know! That's honestly the scary part." He realizes

the importance of GD&T in his line of work and understands that any more exposure or any more GD&T classes he can take will be beneficial. Before we moved on to experiencing the online course Bryan rated his own experience with GD&T as, “Intermediate, but on the lower end of it.”

Following this Bryan began to interact and experiment with the online course. He was asked to provide his expectations and what he expected to see at the home screen of the course. “Definitely all menus that I need to get at on the right or top because accessing the page frequently is what is going to happen with an online course, so I always want to be able to get to everything I need.” Along with having easy access to all course materials on the home screen Bryan added, “I think that having those info bars pop up telling you have an assignment or something like that is good.” He believed that this would help remind him of due dates and keep him on track to completing the course.

After describing his expectations Bryan was asked to begin scrolling down on the homepage and look around without clicking on any hyperlinks just yet. As he scrolled down the page he began to realize how the course was structured and organized, which helps him prepare for the quizzes.

> Oh! These are your sections… I like the way it’s formatted because you’re grouping them into categories, you’re getting your specific areas and the way I like it is that when I’m taking a quiz or I have to study for a test I can remember that specifically in module one it contains certain information and I can remember something specifically from it.

Bryan told me that he is a more visual learner and that he can remember content much better if it is organized. As he described it, “It’s almost like a map in your head to get back there,

it's not a jumbled mess." He also mentioned that he was thrown off at first because he is used to PowerPoint's and thought each hyperlink was one and not a video.

As far as understanding the content and terminology Bryan thought it looked good based on his experience. He did mention that he was currently learning about GD&T through a course at his work and believes that they put datums before tolerances and thinks that may be a good thing to change. He also stated that profile tolerances are a "pretty big callout used now" and that his employer really wants him to use more profile. In addition to commenting on his understanding of the course content Bryan added, "I think a lot of learning comes from discussion and talking about things with other people," which emphasized the success he had with one of his online courses previously mentioned.

Bryan was asked where he would like to start with the course given his experience and to choose a video to begin to watch. He believed that starting at the beginning would be best for him, even though his background suggested he may want to start somewhere else. This is because "different instructors try to drive different points home" and if he jumped into the course somewhere other than the beginning he may miss these key points. Finally, before watching the video of his choice Bryan was asked to comment on his expectations for the video. "Most likely it's a camera on a tripod in the corner following a guy walking around." He proceeded to spend about ten minutes watching the instructional video and it was not at all what he had expected.

Bryan's initial reactions to the instructional video are captured in the following excerpt from the interview transcripts:

I like this format, no it wasn't what I expected, the format was better than expected. The two classes I've had, one was basically pdf's converted into a PowerPoint. It was

> a few lines of text discussing an equation… All he did was write on it and a lot of times it was chicken scratch and couldn't understand what he was writing. What I see here was a little box at the bottom where you could actually see him, which is good in case he talks with his hands more, like me. Or the arrows are clearly defining what he's talking about. If he has to draw on it he's really trying to drive home what he's talking about.

From this passage Bryan brought up two of the design decision that went into creating the course. First, he mentioned how viewing the instructor through picture-in-picture can be beneficial to him. When asked if seeing the instructor helps him he commented, "In a weird way I guess. It kind of personalizes the instructor instead of just having some sort of voice." Second, he began to mention how drawing on the screen, or annotating, helps him understand what the instructor is trying to emphasize. "If he's moving the pen around the screen circling things, I mean in the end all he's doing is underlining or circling, but I believe it does help because it helps you focus." With the annotation he also brought up the fact that he would like to print out the examples so that he can follow along and make his own notes. He believes that this would, "force me to follow him [instructor] and at the same time force me to be engaged with what he's talking about."

Bryan was told that he could choose another video or continue with this one. He chose to go back to find another video, however, he found a way to jump directly to any video directly from the page he was on. This was done through a drop down menu at the top of every screen on the course that allows the student to quickly access all instructional videos. He found this, "pretty nice because no matter where you are you can get to it."

Towards the end of the interview Bryan was asked to provide any drawbacks or comments that we haven't talked about. The only drawback he mentioned was, "not being there." This was because he learns best from being able to ask questions and discussing problems. In addition to the drawback he had a few suggestions that he would like to give to the instructor based on the content and helping him understand GD&T better. The first advice he would give was to use more physical examples, such as wood blocks, to help reinforce his part drawings. Second would be to include two types of examples when showing part drawings. One example that is easy to understand and over the main content which you would be quizzed on. The other example would then talk about "all the crazy or more difficult stuff that could happen" when working with a part design.

Case Study #3: Harley

Harley has been affiliated with part manufacturing and design since 1995, while working for a large Midwest parts manufacturing company. He has solely focused on part design since 2000 after obtaining his designer/drafter degree from a local college while still a full time employee. This was also about the time he realized, "I didn't have the knowledge I needed in GD&T" so he began to study that. He was not sure how to go about finding good and reliable information, but decided to use the Internet as his first resource. By searching for any information he could find he was able to find some valuable resources, but not enough. Next he used his colleagues at work to try and find information but found out, "it's not very easy." He finally found some help from a colleague that was putting on programs for GD&T and had a video series of VCR tapes and a workbook that he used. He liked using this type of instruction but found this presented problems for him.

> My mind just can't comprehend that much all at once, even though I've done the workbook and stuff. Then you go back to your desk after the class is all over and that's the time when you don't need it for a week or a month. Anyway, it starts to fade, and then you realize you need it, and then you have to thumb back through the book to find certain information.

At this point Harley let out a big sigh of frustration in regards to the amount of material and information that GD&T contains and how overwhelming it can be. This is especially true when he needs to know certain elements of GD&T at a given time, then has to spend time going back through the course material to find what he needs. He mentioned his instructor from school talking to him about going through a GD&T certification program and at that time he sarcastically commented, "Yea right!" However, as time went on Harley realized the importance of GD&T. As he was talking with a colleague in engineering service management at his work the colleague convinced him that he should become certified in GD&T. Harley took him seriously and decided he would start studying for the certification exam.

This was where he really became lost because he has been through the video series at work and realized that wasn't enough. So what he ended up doing was "taking the GD&T manual and studying that. When I didn't understand anything I had had to go find the answer out somewhere." That somewhere was, "beyond what they [colleagues] could tell me." So at the time Harley had difficulty making sense of large amounts of information GD&T presents and finding a course or program that was detailed enough for his level of experience. He commented, "If I was to see an ideal program I would like to see GD&T for ISO." ISO stands for the International Organization for Standardization, which sets standards for many

of our worlds products, systems, machinery, and devices (ISO, 2009). So Harley would like to see principles of GD&T applied to the ISO standards that his current employer uses, which he said would be, “getting personal for our company.”

Harley’s experience with online courses is minimal. However, he explained that his company currently uses a self-directed online course for GD&T, “but it is very basic.” It includes animation that he described as a screen with “pictures of part drawings, text on the right is where you can read it, and audio that plays it as you read it. Then at the same time as it’s playing it goes through showing how part features move inside a zone.” Since it focused on the basics of GD&T he said it’s “quite nice, but for somebody that hasn’t been around it before it’s quite a bit to take in, but it gets them started.” Personally, Harley has had no online courses, but did share his one and only experience with attempting to take one.

> One time there was an online course and I was very interested in it, so I signed up for it. It started and I was so disappointed. An assignment came up and said ‘read this, next week read this’ and I was like good grief! You call this an online course? Get outta here, I can figure out how to read a book.

He realized that this may not have been a normal experience as most people, but nonetheless this was what his experience was. Before proceeding into interaction with the online course for this study Harley was asked to rate himself on his level of experience with GD&T. Given his years of experience he said, “Put me in the expert field.” However, he does mention that there is ambiguity on some harder part designs and that when there “isn’t a clear cut symbol for it and you’re trying to determine how to put it on there, that’s where it starts getting complicated.”

Upon login to the online course for this research study Harley was asked to share his thoughts and understanding of the layout and structure of the home page. He quickly understood where the tasks menu was on the left side and noticed the introduction at the top center of the page. From here he scrolled down and began to read off the names of the modules as he nodded his head in agreement. When doing this he understood the terminology for the first four or five modules, but then as he read off names lower on the page he became less certain of what the content was about. For example, when he encountered the term pattern locations he mentioned, “I’m not sure exactly what that means.” Similarly, when encountering another module he commented, “Alignment of surface, not sure exactly what you mean by that.” So some of the terminology of the more complex content was not exactly clear to Harley.

At this time I asked Harley to take a closer look at each module and explain what he is noticing. He realized that each hyperlink was actually a video when he commented, “Well, now that I look at it a bit more there is 18:29, which is eighteen minutes of the video I’m assuming, Ok!” He liked that the videos were shorter, around twenty minutes, which is “something that you can sit down and do in a short time.”

Now that Harley had an understanding of the layout and structure of the course he was asked if he would change the order of anything. After a brief moment of silence while he looked through the modules he stated, “No I think it’s ok. There is really no right or wrong, there is so much to GD&T how do you say put this before that. You know, it just intertangles so much.” This ‘intertangling’ is what Harley said was the most difficult for someone trying to learn GD&T to understand. Following this Harley was asked to choose an instructional

video module to begin to watch. He decided that he would like to see the introduction video "just for curiosity."

After spending approximately ten minutes watching the video I asked Harley if this was what he expected. He responded by saying, "Pretty much, pretty much yea. I thought it would have went into a little bit more of why you would use GD&T." He really emphasized explaining the importance GD&T and the benefits it can offer. Harley also liked being able to see the picture-in-picture video of the instructor. "I think it's very helpful to see him. I don't know why, I just like to watch somebody." He continued, "It's also very important to have this [PowerPoint screen] up here. Then at first when he was underlining things it was just like… what? [As he smiles]." Harley was surprised by the pen annotation so I asked him how he liked it.

> Well, at the very beginning it's kind of sloppy you know. Why not use a highlighter or straight line or something, but after seeing it a little bit, I like it. You know, you get so much into the world of perfection that it's almost too perfect and this is very readable, very understandable and… it's good and I like it, that's all there is to it.

Harley also liked the fact that the annotation "takes your focus off of him and off of these other things and puts your focus on what he's talking about."

At this point he wanted to view another instructional video, but has a little bit of difficulty navigating back to the video modules. At first he used the breadcrumbs and clicks on the previous one, but this takes him to a 'resource' page instead of the main screen and he commented, "I'm not sure what this is." After looking a bit more at the screen he noticed a 'jump to' drop down menu bar at the top right of the screen. In regards to the course navigation he commented, "I'm not good at that kind of thing, most people would understand

it 100%, but the back button gets me back to where I want to go and the ‘jump to’ screen is very nice and intuitive.”

Towards the conclusion of the interview Harley was asked to comment on any concerns or advice he would like to give that we haven’t discussed yet. A major concern of his is about the availability of online resources and how they can change compared to physical resources, such as a workbook. Not physically having the material in his hands concerns Harley.

> If I felt secure that this video would be accessible to me at all times and this video did not change, then I wouldn’t have a problem not having a workbook. But my experience with videos and access to info like this is that they do change. I mean I can just about guarantee that if this is out there, in a couple years it’s gonna change, or the access would not be there or something.”

Another piece of advice Harley gave was to possibly have a table of contents within each video. He thought this would help add another level of structure and make it easier to get directly to information quicker within each video. Further, Harley mentioned he would like to see images that correlate to each module placed next to the hyperlink text on the main page. He feels this would make it, “real fast, quick, and easy way” to get to the desired module you want.

Just before ending the interview I asked Harley if he saw this course as something that could help him. He responded:

> To me personally, I don’t know if I would use it. But, for people at beginning stages I would use it very much and the thing is I’m established in my pattern and this is pretty much knowledge I already have and I’ve got my reference material that I’m

> used to going back and using. So, I would struggle trying to develop something new that I don't know if would gain me anything. So personally, I don't know if I would use it, but at the same time we've got a lot of people out here right now that need to start off and this is an excellent way to go.

Case Study #4: Dan

Growing up Dan was exposed to a lot of hands on projects including rebuilding his first car engine at fourteen years old. He would also work on wiring, plumbing, building homes and other jobs that required fixing broken parts or machines. In addition to this, his father, who worked for a large construction and farm machinery corporation in the Midwest, was a big influence to him. When he graduated high school he didn't have a lot of money so he attended a small technology school and graduated with a mechanical design degree. The following passage by Dan describes how he became a part designer and why GD&T is important to him:

> So I graduated from high school when I was seventeen and got a two-year degree and then I hired on that year [with the same company his father worked for] when I was nineteen. I started in the drafting department, from there I moved into the design. I worked in design from 1972 to 1980, or somewhere around there. I was trying to do a few things with my designs so, I wanted to have some of this GD&T stuff cause we were using it very poorly and that it was basically non-existent. Of course they didn't want me to necessarily print this stuff because it was too confusing, but to make a long story short, I started teaching back in 1980 because they did get it sold [referring to the use of GD&T]. I became the corporate guy for GD&T and they asked me to be involved in the ASME standard, so I was one of the co-authors of the 1994 standard.

Dan went on to explain that he was part of many committees that reviewed documentation for GD&T standards and he even founded a group that consults with outside companies. He also mentioned he was “the first to use GD&T on a drawing, first to use datums, and first to use zero position tolerance.”

Given Dan’s experience with teaching GD&T I wanted to know what question he received the most about GD&T. He explained that it all depended on the purpose of GD&T and who his audience was. “To start out with someone who doesn’t know anything about it they’d say well what is it? What do you use it for? Why doesn’t the old way of doing things satisfy it? Why do I need to know this know?” He went on to say that his company now uses an online course consisting of about thirty or forty hours of content. However, “most courses I see tend to be a reaffirmation of what the actual standard is saying. What is not in the course is the application.”

This application idea was very crucial to Dan’s way of understanding and teaching GD&T. He proceeded to provide an in depth example referring to straightness and tolerance zones and brought up the fact that every specific part application may differ from one to the next, therefore, certain elements of GD&T need to be applied. Dan was so knowledgeable of GD&T that he even “coined a few terms” such as, “clearance equals tolerance.” After explaining more specifics of the content of GD&T he compared the GD&T language to the Webster dictionary. He explained:

> The dictionary doesn’t make sentences for you; it just gives the definitions of the words. Therefore it is up to the individual to use the right combination of words and proper grammar to make a coherent sentence. The same is similar with GD&T; the

standards are just rules and definitions, but applying them involves more understanding and the right application.

In Dan's experience with courses on GD&T he noticed a lot of mistakes being made. "The course we use online is not bad, there area few mistakes in my opinion." To him a lot of wrong terms are being used by instructors, which can cause major confusion to the person trying to learn it. He proceeded to describe a very specific example of how he likes to teach GD&T where he tries to keep it simple for the students and easy for them to relate to. Dan informed me that he has taught over nine thousand people in his career and explained, "During that time frame I have taught a lot of people that have taken other classes and courses and everybody that comes to my class says that it is so different than anything they've ever been to." Further, he pointed out that, "with the current standards system we're trying to make it too complicated." He believes that relating to concepts and ideas of GD&T to the students' everyday experiences will develop better understanding. He proceeded to tell me about specific examples of how he does just that. In addition to providing specific examples Dan broke down how he liked to teach GD&T to me by saying, "When it comes down to the actual standards themselves, I probably teach that in the first four hours. The class I used to teach was fifty-two hours long, now I cut it down to about twenty hours." Dan continued to display his knowledge of GD&T and provided more understanding on how he likes to teach certain components of it. He explained that his course is all based on questions and examples the students have. He uses only a whiteboard and no PowerPoint's because "depending on the question, I will be changing and I will be giving examples and saying why can't I do it this way? So I put it on the board so everybody else in the class can see what this one student is talking about."

After understanding Dan's background on teaching and applying GD&T he provided more examples of how he likes to use simple everyday examples to teach his course. For the more advanced learners he likes to ask them lots of questions to get them thinking and looking at designing a part from multiple perspectives. He believes that GD&T eliminates the need for interpretation and "gives meaning" to a design feature and that everyone should have the "same meaning" so that nothing needs to be interpreted because that is where ambiguity can come in.

When Dan was asked about his own experience with taking any online course he mentioned that there was a lot of mandatory classes through human resources he had to take.

> "I think most of them are fine because you can take them on your own time and schedule. That part is a plus. But when it gets into a technical subject like this [GD&T], I have a harder problem with it, only because with an online course I can't ask a question if I don't understand something and expect to get an answer back.

Dan goes on to say that there are a lot of benefits to online classes, such as being able to show 3D graphics and ability to visualize some of the basics. As he put it, "This is basically my first four hours, then I switch to the application after understanding the basics." Following this I helped Dan login to the online course and we began to discuss his understanding of what he visually sees.

Immediately after Dan logged in and the home screen showed up, he noticed a picture of the instructor on the screen and asked, "I'm curious, where did he get his background from on GD&T?" So I told him that he can click on the hyperlink that takes you to the instructors website where you may be able to find that information. Dan proceeded to look around the instructor's homepage and wanted to know his background on GD&T and if he has attended

the ASME meetings or knows certain people from the organization. He believes that knowing an instructors background can give you insight into how he would teach and what he knows. Dan then continued to explain and give specific examples of how a different persons background on GD&T can affect their knowledge of how it is applied.

After discussing the importance of the instructor's background I asked Dan what he thought about the layout of the content and modules. He responded by saying, "Maybe the sequence I would change them around personally. What I do is I have a part and hold the part up and talk about definitions of it." He then proceeded to explain how he would teach the basics of GD&T based on this one part. Dan suggested and described that he always starts with datums and describes basic examples to students. He then provided an example of how he does that. Following this discussion Dan began to watch one of the instructional videos.

Two or three minutes into watching the selected video Dan asked to pause the video because, "there are too many things I have questions about." He was distracted by what he saw as errors in the videos and proceeded to discuss what the content should be like. He commented, "I don't want to pick on the guy, but I'm just saying those mistakes are there and can detract from the content you are trying to get across." He believes that the choice of terminology can be confusing if not used properly and that can lead to confusion for younger learners of GD&T. He added:

> The purpose of GD&T is to take ambiguity out of the terminology used so that it is less confusing and not a turnoff to new students. I do make mistakes also, but on a video you can't correct yourself on the spot because it is recorded. From my perspective and my experience and when I go through here [instructional video] and

> something like that jumps out at me, all of a sudden I'm distracted. It's a distraction because now it's saying something I don't believe totally.

After continuing to watch the video a few more minutes Dan continued to point out these ambiguity points and how it can lead to confusion. He provided me with GD&T examples and how he would teach them. At one point Dan became so passionate about what he was describing that he got up and went to the white board in the room and taught me for fifteen minutes about an element of GD&T and how he would teach it to other students.

Once we were sitting back down I asked Dan what he thought about being able to see the instructor through picture-in-picture and also what he thought about the on screen annotation. He commented:

> I do like it, that's what I like about it, I really do. Because when I just listen and I'm looking around trying to find something I'm not really concentrating well. But if he can get me to where he is talking about right away by pointing it out, that's great!

Towards the conclusion of the interview Dan reiterated a point he made earlier about using simple examples that everyone can relate to. "I'll use doors on a wall, pictures, hoods on their car, anything that allows for more students to relate to what you're trying to explain." After he described a few more examples of what he uses to teach to his students we concluded the interview.

Theme Analysis and Discussion

Structure and Content

There is almost like a map in your head to get back there, it's not just a jumbled mess.

The participant's experience level with the content of a course is an important element to consider when structuring complex content. The two younger participants found that the layout and structure of the course met their needs. Adam expected the course to look like it did based on his previous experience with other online courses and stated, "It's basically like a course syllabus that outlines all the stuff." In addition, Bryan added "I like the way it is formatted because you're grouping them into categories, you're getting your specific areas." He goes on to say, "There is almost like a map in you head… it's not a jumbled mess." Further, we are able to see that Adam's understanding of the details of GD&T require him to think about and convince himself of what he believes is correct. From his think aloud about how he understands elements of GD&T we are able to see that he follows a path. This path or 'map' allowed him to make sense of information in his head until he gets to a point where he is at equilibrium with what he believes and knows. Purposely structuring content to fit learners prior knowledge and existing conceptual structures allows the learner to easily assimilate and make sense of new information (Piaget, 1973).

However, the two more experienced participants made no comments about the structure. The only comments they made were on how they would re-order the content. Both Harley and Dan mentioned they would start with features or datums first. Dan commented, "Well if you're going to start with anything, first of all I could start with datums or start with features." The reason for this may be their increased level of expertise on GD&T and the fact

that they both have taught a course in it. Given that they know more than the basics, unlike the younger two participants, they have more of an understanding of the content and how to apply it to the field. Adam and Bryan have only been exposed to the basics of GD&T and may not realize the small intricacies that it entails and therefore have less input on the order.

In addition to the experience level of the participant affecting the structure and order of the content, Harley mentioned that he would like to see even more structure within the instructional video modules. He mentioned he would like to "have it broken down into sections and periodically have a little review after each one." He also brought up the idea to "have a table of contents over to the side of each video." This is interesting because no other participant mentioned the idea of adding another layer of structure to the videos. However, many times during Dan's experience with the course he would begin to teach me about the many details of GD&T and how specific it can get. Based on his level of detail and specific explanation of part design, I believe this reinforces Harley's idea of adding more structure. If there were a way to structure these more specific details, maybe the idea of Harley's table of contents would be it. This also provides insight into answering the first guiding question for this study: Does the level of prior knowledge with course content influence the degree of organization and structure preferred by the learner? In this instance yes; however, the instructional designer for a specific course may need to evaluate their individual learners first to determine how structured a course may need to be.

Implications. So what does this mean for instructional designers? First, when designing instructional programs for less experienced individuals you must provide a structure that allows them to quickly assimilate and organize the content. Second, the more experience an individual gains on a particular subject matter, more detailed structure and

organization may required. Finally, presenting content in an order that builds on previous information is important, but as an instructional designer you must be positive that you have researched the best possible way to do this. Gaining input from an expert in the field is one way of accomplishing this.

Annotation

When I just listen and I'm looking around trying to find something I'm not really concentrating as well. But if he can get me to where he is talking about right away by pointing it out, that's great.

Focus, concentration, engaging, and attention are all words described by the participants from experiencing the on screen annotation. Every participant found that they were quickly drawn to the exact location on the screen where the instructor was referring to, therefore drawing the learner's attention to what he is saying. What this does is "really drive home what he's talking about" as Bryan explains. In addition, Bryan also points out that a lot of the time instructors can "muddy" the text or screen too much and make it hard for the student to actually see what he meant and make meaning from it. The quality of annotation used here "is very readable, very understandable and it's good" explains Harley.

Another interesting piece to the experience with the on screen annotation is that it is not perfect. Harley explains, "You get so much into the world of perfection that it's almost too perfect." It seems what he is referring to is the fact that part design drawings are so detailed and intricate that you must be a perfectionist to be able to create or read them. He was so used to seeing exactly straight lines and perfect circles that he seemed to enjoy the personal and authentic touch that pen tablet annotation offered.

Implication. Obtaining and maintaining your learners' attention and engagement is critical in order for them to understand the content (Keller & Suzuki, 1988). Therefore, the incorporation of pen tablet technology can prove to be beneficial when designing and developing online instructional videos. It can help the learners' focus, maintain their concentration, and provide an authentic feeling. Based on my experience with this course, I would recommend that the instructor take the time to become familiar with this new technology and practice before any video capture is required. As for the guiding question, do participants perceive a sense of engagement/interaction with the course content through the use of on-screen annotation in the instructional videos? It appears that these four participants believe it does.

Picture – In – Picture (PIP)

It kind of gives you a connection with the actual person talking.

All of the participants had similar remarks as Adam did in the quote above. There was something about seeing the actual instructor in front of you that each participant liked. As Bryan puts it, "It kind of personalizes the instructor instead of just having some sort of voice." Social constructivist theory (Vygotsky, 1978) emphasizes the critical importance of interaction with people, including other learners and teachers, in cognitive development (Huang, 2002). During social interaction knowledge construction occurs between learners and instructors during back and forth dialogue as well as visual communication. Participants in this study alluded to the fact that having the PIP, as well as the pen annotation, mirrored or imitated the elements of dialogue and visual communication. Thus, it provided them with a perception or feeling that they were interacting with the instructor.

In a self-paced online course it is impossible to have student – instructor interaction because you are not physically in the room with the instructor. However, Bryan brought up the idea of perceiving to have social presence when commenting, “A positive thing you get out of it besides that [referring to personal feel] is if he had an actual part to show or discussed something a certain way to where he needed to use his hands.” So, incorporating picture-in-picture appeared to present the perception of student – instructor interaction, which relates to the third guiding principle of designing online self-paced corporate training. So, to answer the final guiding question for this study, do participants perceive a sense of social presence/interaction/connection between the instructor and themselves through the use of PIP? Based on the participants’ experience, yes.

Although all of them agreed that having the PIP of the instructor was nice and helpful, Harley only made one comment about it saying, “I don’t know why, I just like to watch somebody.” Similarly, Dan commented, “I do like it” but then proceeded to talk more about the content and his way of teaching. It seemed that Dan was too distracted by the quality of the content that he did not pay too much attention to the PIP. This would suggest, because of Harley and Dan’s high level of expertise with the content, they had less to offer on the PIP and were focused more on the content.

Implication. As an instructional designer this can be a valuable tool. Having PIP can be a great way to improve the personal feeling one gets from seeing the instructor as they teach. With difficulties of providing social interaction among self-directed online courses, the addition of PIP can help to provide this perception. In addition, it is important to use proper video capture techniques so this perception can be maximized. When incorporating picture-in-picture “eye-to-eye contact is essential for the sense of emotion and trust” (Sponberg,

Knudsen, & Handberg, 2001, p. 5). However, if the PIP draws too much attention and takes away from the content that is being displayed, then other measures must be taken. One suggestion would be to hide the PIP of the instructor when he or she is presenting an example so that the visual focus shifts to the content on the screen.

Application of the Content

In addition to the three instructional design decisions, an interesting theme emerged when interviewing Dan. From reading his case study description you can see that he had a passion for GD&T and teaching it to others around him. I believe this passion stems from his early involvement as a co-author of the initial GD&T standards of 1994. Being one of the first to implement elements of the standard on a drawing, such as "first to use datums, first to use zero tolerance, and first to put GD&T on a drawing," Dan had more invested in the language of GD&T than almost anyone that has ever used it. Being able to talk with someone with his experience allowed for me to gain valuable feedback on the content of the video modules. However, with Dan having so much experience with GD&T he was not interested in the video modules and would repeatedly refer to specifics of part design and even begin to teach me. Many times during his interaction with the course Dan would stop the video because he felt an example wasn't explained correctly. He then proceeded to walk up to the whiteboard in the conference room and began to teach me the proper way the example should have been explained based on the way that he has taught it for years.

To delve in deeper, it appeared that Dan was mainly distracted by the video content of the GD&T course because he felt it lacked application of the GD&T standards to real-world problems. Dan believes that using a constructivist viewpoint and providing simple everyday examples to teach new learners about GD&T would provide more connection for them.

Many times he referred to the fact that he uses students actual part designs and questions they have to guide his teaching. Finally, he added that he would use this course as an introduction to GD&T if some changes were made, but didn't see it having any use for those with more experience with GD&T. Only one other participant, Harley, mentioned the same thing as Dan. He felt that the GD&T course would be useful for beginners to GD&T but felt that it had no value for him given his many years of knowledge. On the other hand, the two less experienced participants found that any exposure to GD&T could only help their cause. They believed that any resources that could explain the basics of GD&T to them would be helpful and especially liked the short duration of the videos.

Implications. For instructional designers it is very critical that you know what the experience and knowledge level is of your adult learners (Knowles, 1970, 1984, 1990). Designing online content and providing resources that are not geared towards your learners' needs can be a distraction and useless if their experience level is higher than what you thought. In other words, the content must be relevant to the learner so he or she will become active in their learning, which is the second guiding principle of designing online self-paced corporate training.

In addition, use advice from an expert in the field. In this instance more application of the content should have been included in the instructional videos. Allowing the learner to apply their understanding of the content can be an excellent way for them to learn on their own and learn from their mistakes. It is very important for the adult learner to be able to apply their knowledge to real-life situations (Knowles, 1984, 1990). Further, if you can gain access to an expert in the field that also has experience teaching the content it may prove to be very beneficial. Having their input and insight into their experience with teaching a

specific content can eliminate time spent trying to figure out the best ways a course should be designed.

Course Navigation

Online course management systems (CMS) can prove to be a valuable tool when designing an online class. All four participants with this course found a feature within the CMS that allowed them to ‘jump to’ (figure 6) any instructional video from the page they were on. All found this a quick and useful way to quickly access other pages within the course without having to go back to the home screen every time. Although they found this ‘jump to’ feature useful it was not very intuitive to each participant. When Harley wanted to go back to the home page and select another video to watch he decided to use the ‘breadcrumbs’ shown near the top of the page. He figured if he just clicked on the previous level within the breadcrumbs he would be taken back to the home page since he just came from there. However, he was brought to a resource page that contained all of the courses resources. This really confused him as he commented, “I’m not sure what this is.” He went on to comment, “I’m not good at that kind of thing, but the back button gets me back to where I want to go and the ‘jump to’ menu is very nice.”

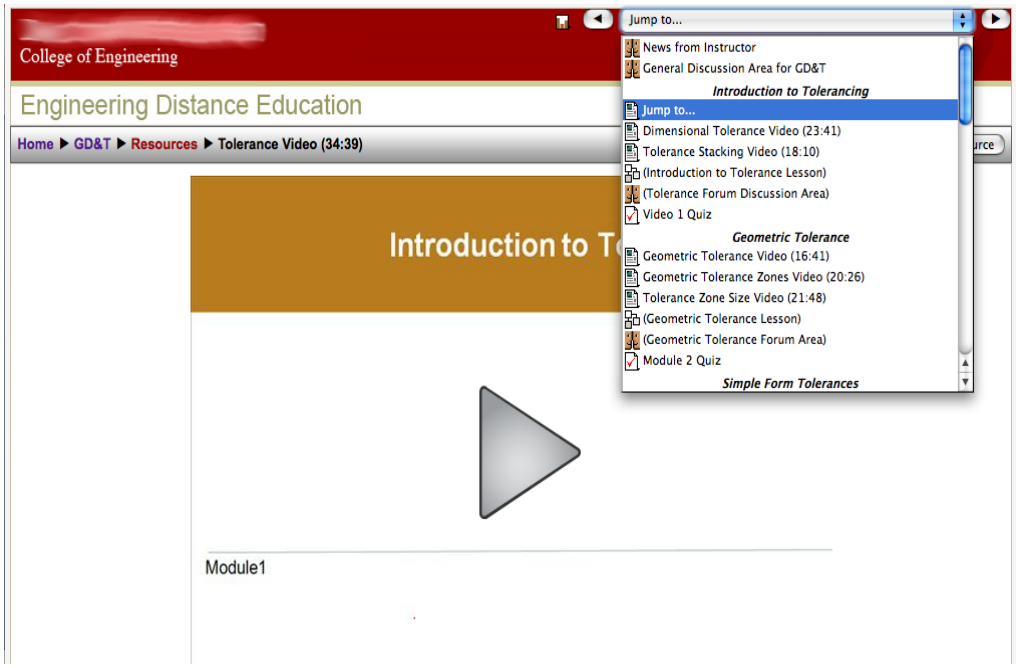

Figure 6: GD&T course screenshot of jump to feature

Implication. Provided the responses by the participants and one participants struggles with navigating through the course, instructional designers must be aware of the learning curve that comes with learning a new CMS. It may prove to be useful to have an introduction to the course that explains how to access the content they will need and how to use features of the CMS that will benefit the learner. By doing this the learner will not have to worry about learning how to use the CMS and can concentrate on learning the content of the online course.

Conclusion

As self-paced online corporate training becomes more pervasive in our society it is important that courses used for this type of training utilize research-based instructional design principles. Three guiding principles were presented in this study and were the basis for the three instructional design decisions that were incorporated into the training course. These included: structure of the course content, personalization of course content through the use of picture-in-picture, and engagement with course content through on-screen annotation. Four case studies of adult participants' experience with the course were described and analyzed.

Results showed that using the three principles for designing self-paced online corporate training provides guidance for instructional designers. Specifically, learner's experience level with the content affected how quickly one assimilates to the new knowledge. The less experienced learner requires organization and structure of complex content to allow for increased assimilation. Also, the more experienced the learner was, more structure was preferred. Past research (Potelle & Rouet, 2002) has shown similar findings and that learners with low prior knowledge benefit from well-formed structures like hierarchies (Shapiro & Niederhauser, 2004). In addition, the less experienced learners displayed less criticism of the order of the content than the more experienced learners. The incorporation of on-screen annotation improved all learners engagement by directing their attention and focus directly to where the instructor was referring to the content. When designing courses that require the use of instructional videos it appears necessary to include the use of on-screen annotation to improve the learner's concentration and engagement. Finally, the use of picture-in-picture did create a sense of personalization and increased perception of social interaction with the

instructor. Instructional videos can be used to incorporate the use of picture-in-picture to provide the learner with a connection to the instructor rather than just voice narration.

Also emerging through this study was the importance of relating the content to everyday examples the learner would face at their work place, as well as providing opportunities to apply the knowledge they are learning. In addition, another theme was the importance of designing a course that is intuitive when it comes to course navigation. One should not assume that all learners would be able to comfortably navigate, or access, all of the course features. The previous two themes were beyond the scope of this research study, therefore I would recommend further research be conducted regarding self-paced online training that looks at: What are effective strategies for learners to immediately apply there knowledge gained from a self-paced online course? How to design intuitive course navigation, especially when encountering a new course management system? How can social interaction be effectively incorporated into self-paced online courses?

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Appendix

Interview Agenda and Questions

The purpose of this interview is to explore the participants experience with online educational courses, gain insight into their background with Geometric Dimensioning and Tolerance (GD&T), and gain insight into their attitudes, perceptions, and experiences with instructional design features of the course. The interview process consists of one interview approximately two hours in length. It will be video recorded for transcribing purposes and member checking. The interview will be semi-structured and will consist of open-ended questions to allow the participants to express their thoughts and experiences. Below are the agenda and questions that aim at answering the research questions.

Agenda and Questions:

- Prior to interview
  - Set up camera and tripod
  - Have copies of informed consent and purpose of study
- First Part (10 – 15 min)
  - Introductions
  - Review purpose of study
  - Obtain informed consent
  - Begin recording camera
- Second Part (15 – 20 min)
  - Gain background knowledge and prior experience – focus on becoming a design engineer, experience with GD&T, and experience with online courses.
  - Questions include:
    - What experiences in your life led you to become a design engineer? Why is design engineering important to you?
    - Can you explain the path you took that put you in your job position now?
    - How many years have you been working with part design?
    - What level of expertise would you consider yourself as a design engineer?
    - Why do you need to know GD&T?
      - Can you explain how GD&T impacts your personal work?
      - How have you come to learn GD&T to this day?

        - How do you see a self-training course, like this one, integrating with your need to learn GD&T for your job?
    - How long have you been using GD&T with your current job?
    - What level of knowledge do you consider yourself to have with GD&T?
    - Please explain your past experience with online courses?
        - Can you explain the context of the courses?
        - Have you participated in any self-directed/self-paced online courses? If so please explain some details of the course?
        - Was it an enjoyable experience? Please explain?
        - Would you take another self-directed course?
        - Have you experienced any type of training videos or courses that incorporate annotation? How about picture-in-picture? If so, please explain.

- Third Part (10 – 15 min)
    - Login to GD&T course on Moodle and have participant look at home page. Focus is on the organization and structure of the course.
    - Questions include:
        - Can you explain your initial thoughts when first viewing the home page of the course?
            - From looking at this screen what can you tell me about what you think you are going to see next?
            - What are your expectations?
        - What is your understanding on how the course is set up? Can you explain?
        - In regards to the name of each module, do you understand the terminology (relating to GD&T)? Please explain.
        - Does seeing so many instructional videos seem overwhelming?
            - Could you explain how you would like to see them arranged differently?
        - Tell me what you like/don't like about the layout of the course?
        - Is there anything else you would like to add that we haven't talked about?
        - Is there anything missing that you feel should be in there?
        - If you are familiar with GD&T what module and instructional video would you choose to view first and why?
- Fourth Part (Approximately 45 min)
    - After last question have them choose a video to view and explain that you will be asking them question while they watch one of the instructional videos. Focus is on the annotation and picture-in-picture features.
    - Questions include:

        - Is there anything that made this course feel personable to you?
        - After watching the video did you find it helpful to have the video of the instructor talking?
            - What was it about picture-in-picture that was good or not good to you?
        - What are your thoughts about visually seeing the instructor as he explains and demonstrates concepts of GD&T?
        - Does seeing him and looking at him help in engaging you with what he is explaining?
        - You notice he was writing on the screen and annotating along with talking.
            - What are your thoughts about the seeing the instructor demonstrate problems and explaining their thinking with on screen annotation?
            - Does it help you understand the instructor and material better?
        - What are some drawbacks to the instructional videos that you can think of?
        - Tell me what you don't like about the instructional videos?
        - Is there anything else you would like to add that we haven't talked about?
    - After asking questions about the instructional design features I will ask questions about the content of the course including:
        - Tell me what you think about the content of the instructional video?
            - Does it make sense to you?
        - Do you feel that the content is too basic? Too difficult? Please explain.
        - What did you find confusing? Please explain.
        - If you could give the instructor any advice what would it be?
        - What other comments or suggestions could you give?
- Conclusion
    - After all questions have been asked I will tell the participant that they can feel free to navigate around the site more and watch portions of videos that they have not watched yet. I will continue recording their actions and allow them to ask questions to me.
    - Once the participant feels they are finished with experimenting with the course the interview will end and recording will stop.
    - Thank them for their time and ask if they would like to see a copy of the final report.